

OBSERVATIONS ON THE ECOLOGY, BEHAVIOR AND
LIFE CYCLE OF THE FUNGUS-FEEDING BEETLE,
CYPHEROTYLUS CALIFORNICUS, WITH A
DESCRIPTION OF THE PUPA (COLEOPTERA:
EROTYLIDAE).

BY ROBERT C. GRAVES¹

Little is known concerning the habits of *Cypherotylus californicus* (Lacordaire, 1842), the only species of Erotylinae known from America north of Mexico. The larva is described and illustrated (as *C. boisduvali* Chev.) in Peterson (1951), who also notes: "Larvae associated with fungi on fallen logs from Arizona." Smyth (1934), as quoted by Boyle (1956), comments as follows: "I at one time collected a very large number of them in one day, grouped around fungi on the undersides of decayed logs in a damp, shady spot among pine and alder trees in Oak Creek Canyon, south of Flagstaff, Arizona in August, 1904." Boyle (1956) observed this species in southern Arizona, "its range apparently correlating well with that of . . . *Pinus ponderosa*." He further states that "the gut content of a dissected specimen consisted of bits of fungus-riddled, apparently coniferous wood."

On August 7, 1964, I discovered several hundred larvae and pupae of *Cypherotylus californicus* at Black Canyon Campground (U. S. Forest Service camp adjoining Hyde State Park), Santa Fe National Forest, Santa Fe County, New Mexico. The elevation is 8,500 feet. The host fungus was *Polyporus adustus* Willd. ex Fries.

Both larvae and pupae were suspended from the underside of a fallen aspen log about 25 feet long. The larvae and pupae were grouped into clumps of 4, 35, 46, 60, etc. individuals each. One such clump is shown by fig. 1. This log was held roughly 1 foot above the forest floor by its branches.

Larvae and pupae which hang freely in the air may be a modification associated with high rainfall of the habitat. During my stay at Black Canyon it rained daily and the weather was damp and cold at that altitude. On Aug. 6 there was a severe hailstorm. Under such conditions pupae sheltered by the underside of a log and roofed by shelf fungi would be reasonably well protected. Excess water drains from pendulous pupae and they dry more rapidly as air circulates on all sides. This may be of advantage in reducing growth of molds.

No adults were found at the site, but one was captured crawling on a pile of firewood in another part of the campground. This individual had striking blue elytra which faded to grey after death. All reared specimens were grey. Perhaps unnatural conditions in my rearing cartons prevented the normal development of the blue color. Boyle (1956) mentions a "purplish" color of living specimens.

¹ Department of Biology, Flint Community College, Flint, Michigan 48503.

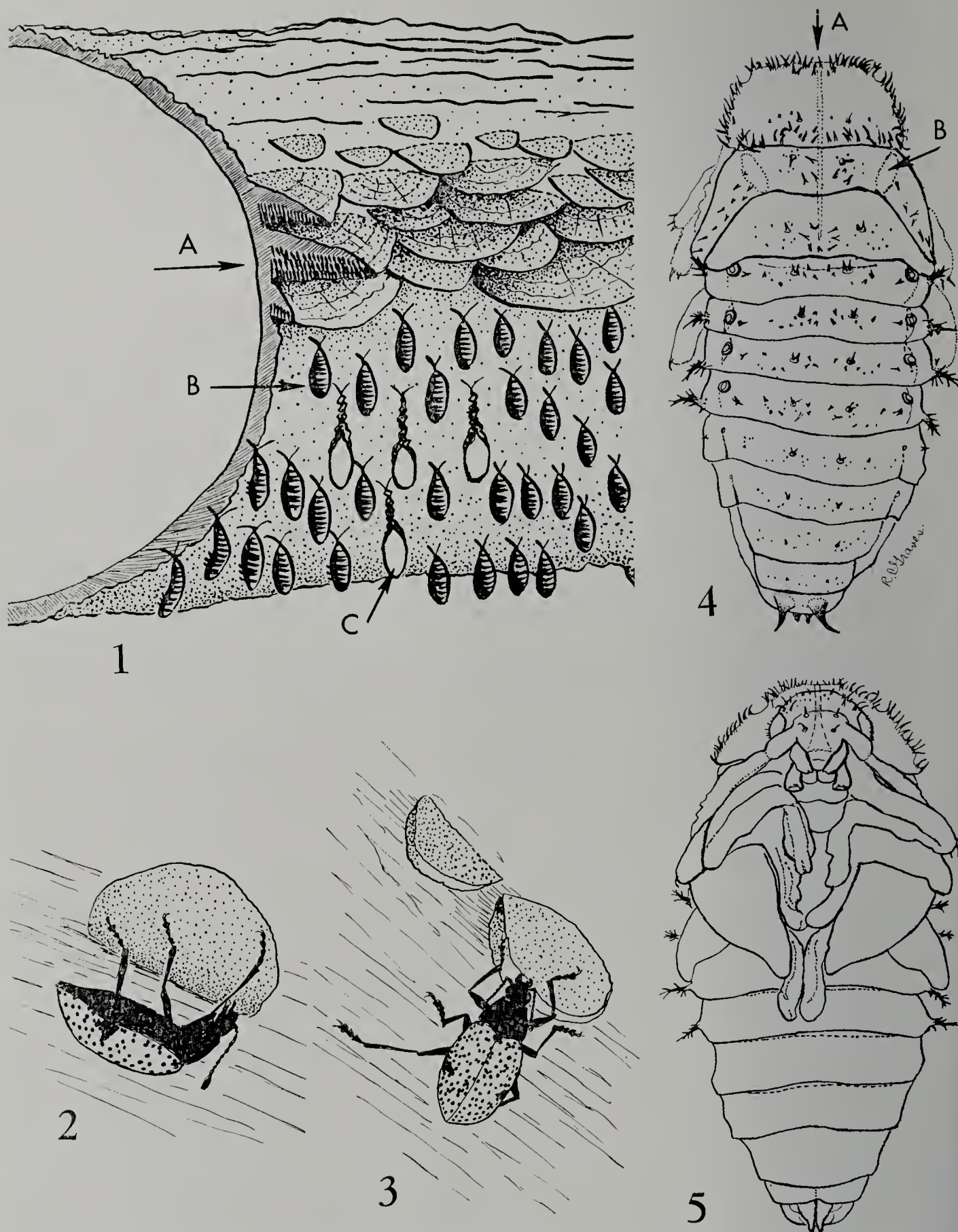


FIGURE 1, Section of aspen log showing (A) roof-like layer of *Polyporus adustus*, (B) larvae ready to pupate, and (C) newly-emerged pupae. Several similar clumps of *C. californicus* larvae and pupae were located on both sides of the log. Pupae are suspended by the cast larval exuvium.

FIGURE 2, Adult *Cypherotylus californicus* feeding (in typical upside-down position) beneath a fruiting-body of *Polyporus versicolor*.

FIGURE 3, Adult *Cypherotylus californicus* feeding on fresh, growing edge of *Polyporus versicolor*. The beetles almost always assumed a position beneath the spore-fruit.

FIGURES 4 and 5, Dorsum and venter of the pupa of *Cypherotylus californicus* (Lacordaire). (A) mid-dorsal white line; (B) yellow humeral spot.

METHODS AND MATERIALS

Larvae and pupae were freed carefully from the log to which they were firmly attached apparently by some sort of anal secretion. Fifty larvae and pupae were collected for rearing and placed in paper ice-cream cartons with tight-fitting lids. A few small holes were punched in these for ventilation and pieces of fungus from the original log were enclosed and moistened daily to prevent desiccation. All larvae were nearly ready to pupate, and all had pupated by the following day (August 8). There were no fatalities during pupation.

Specimens of larvae and pupae were also collected and preserved in 95% ethanol. These served for the description of the pupa (see below).

Adults all emerged on August 15 (none had emerged by evening of August 14). Although four individuals had malformed elytra, there was 100% emergence, even in the abnormal situation of the bottom of an ice-cream carton. None had any difficulty in freeing themselves from the pupal exuvium. (At the time of emergence I was located at Moab, Utah.)

The newly emerged adults soon devoured the original fungus and this was replaced by other fungi collected at intervals along the route.

Five adults had died by the time of my return to Flint, Michigan, on September 10. The remaining beetles were then housed in a large terrarium and provided with decaying logs covered with fresh *Polyporus versicolor* L. ex Fries. Feeding continued (see below) but the individuals gradually died; the last survived until November 27, 1964.

BEHAVIOR OF ADULTS

The adults were observed regularly from August 15 to September 10 in the ice-cream cartons, and from September 10 to November 27, 1964 in the terrarium. It was not possible to observe normal activity in the cartons without disturbing the beetles but the terrarium was most satisfactory.

Non-feeding behavior. Teneral were quiescent for about two days following emergence, but, as the cuticle hardened, they became more active, walking about in a methodical, mechanical fashion if disturbed. If not disturbed, resting, feeding activity (see below), and slow movements were the only behavior. *C. californicus* is not an active species but individuals can crawl rather rapidly when irritated. The long ungainly-appearing legs are beautifully adapted for carrying the animals over the rough bark of logs and fungus fruiting-bodies which form their habitat. When walking, the body is held well away from the substrate; when resting upright or in a crevice, the legs are drawn up and the body is appressed closely to the substrate.

These beetles spend a great portion of their time on the dark, undersides of logs. There, whether feeding or resting, they hang in a characteristic upside-down position (fig. 2). In this common posture they frequently hang by only three or four legs. Again the long legs serve the purpose well, allowing air to circulate freely around the body. As

is the case with larvae and pupae, this may be an adaptation to the rainy climate, allowing water to drain and permitting more rapid drying.

No mating activity was observed. None of the individuals were seen to fly. Rarely, during the day, one would crawl to the top of the log, elevate the elytra and stretch the metathoracic wings as if to take off. The wings appear perfectly capable of flight which undoubtedly occurs under the correct conditions.

On numerous occasions in the terrarium, smaller arthropods such as ants, spiders, isopods, etc. crawled over *Cypherotylus* individuals without eliciting any noticeable response. Once a small spider ran up a leg and onto the elytra; it was wiped off by leg action. The body is frequently scraped clean by the long legs and the legs are rubbed together during cleaning activity.

Most activity consisted of feeding (see below) and resting motionless for long periods. General activity lessened progressively with age.

Feeding activity. In no case was there cannibalism, nor were there any attacks on one another and no appendages were lost. Even in the crowded ice-cream cartons, individuals lived in complete peace, crawling over each other with no sign of aggressive behavior. Dead or moribund beetles were not molested.

Feeding was limited to soft polypores (Basidiomycetes: Polyporaceae) similar to those found in such abundance on the original log. Soft agarics were presented but refused after inspection with the antennae. The beetles fed first on the tender young "nubbins" ("stage I" of Graves, 1960), next on the fresh, growing edges of the older conks (always feeding from the underside of the shelf-fungus, fig. 3). Young sporocarps were completely devoured down to the bark of the tree; in the case of older conks the pore layers were completely destroyed but the tough, leathery caps were not eaten.

Feeding was voracious and the colony consumed an enormous amount of fungi. *C. californicus* may be of some value in the control of wood-damaging fungi as they rapidly destroy the sporocarps *before* spore production occurs. I know of no other polypore feeder which is effective in this manner (Graves, 1960). It is still difficult to believe that such an inactive species should require so much food. Perhaps the fungi are of little nutritional value or the beetles' digestion is not efficient. Large amounts of feces were produced, identical in color to the conk and quite fine and dry, resembling sawdust. Dry or hard fungi were not eaten, nor was wood.

LIFE CYCLE

C. californicus, like other erotylids, is closely associated with fungi, and must be termed a "mycetobiont" or "obligative mycetocole" (see Graves, 1960). I did not observe oviposition, nor find early larval stages although I took the log apart. When sifted over hardware cloth onto a sheet, the fungi yielded Collembola, Cisidae and several beetle larvae, but no *Cypherotylus*. It seems apparent that this species does not have overlapping broods.

The life cycle may be reconstructed from the available data. Eggs are laid on or near the host fungi and the larvae feed on these fungi throughout their development. The black, mature larvae leave the fungi, attach to the underside of the log and pupate. The larval exuvium splits dorsally but is not completely shed, remaining attached to the posterior end of the pupa. The pupa is thus suspended freely from the log by the old larval exuvium, and, therefore, hangs lower than the larvae. In all cases, both larvae and pupae hang with the ventral side facing the log, presenting the dark dorsal side to view.

The pupal stage of the Black Canyon specimens lasted one week but the time undoubtedly varies with local conditions. The adults emerge, move into the fungus, mate, oviposit and the life cycle is repeated. The close timing of emergence indicates that all developed from eggs laid at approximately the same time. This would ensure no difficulty in finding mates. After mating, a number of females probably fly to oviposit on suitable fungi in other parts of the forest.

Had it been possible to provide the original conditions, the captured beetles probably would have oviposited in late August or September. The young larvae probably hibernate in the fungus and develop rapidly during the following spring and early summer, pupating in early August. Adults emerge in mid-August. Although the captured adults fed readily, none survived November, so it is likely that the adults do not hibernate.

DESCRIPTION OF PUPA

(FIGS. 4 and 5)

Total length 15 mm.; width 6 mm. With numerous stiff spines or styli (sometimes branched) which bear a small seta at tip. Color: white (with dark brown styli) in recently pupated specimens, becoming dark brown with age, except for sternites, a distinct white line from clypeus onto mesonotum (fig. 4), and two elliptical yellow humeral spots (fig. 4).

Head with two pairs of large styli between eyes, two pairs of large supraorbital styli (somewhat variable), a number of scattered medium and small styli on vertex. Small styli border lateral margins of eyes.

Pronotum bordered with numerous large styli which are often curved and sometimes branched. Mesonotum with a few large styli on disc and others along elytral buds. Metanotum with large and small styli scattered on disc. Thoracic and abdominal tergites with pairs of "central styli" on discs; these are usually (but not always) larger than surrounding discal styli and are often bifid or trifid; they can be identified by their position, forming two distinct dorsal rows.

Abdomen with first four visible tergites having prominent papillate spiracles and very large laterally-projecting dendritic styli. Posterior segments with greatly reduced, scarcely visible spiracles, without dendritic styli. Last segment with two urogomphi (much shorter than those of larva, which are almost half body length).

Legs and antennae flattened against body. Legs with a few styli at femoro-tibial joint. Venter glabrous.

While all the abdominal spiracles are prominent in the larva and adult, only the first four appear to be functional in the pupa. Also the large dendritic spines laterad to the spiracles are present on abdominal segments 1-8 in the larva but only on segments 1-4 in the pupa. Are these protective to the spiracles, perhaps keeping them separated from foreign surfaces?

The last larval exuvium continues to cover the posterior half of the abdomen, so it is doubtful that the posterior abdominal spiracles, even if functional, would be of much use.

ACKNOWLEDGEMENT

I wish to thank Dr. Josiah L. Lowe of the State University College of Forestry, Syracuse, N. Y., for his determinations of the host fungi.

LITERATURE CITED

BOYLE, W. WAYNE

1956. A revision of the Erotylidae of America north of Mexico (Coleoptera).
Bull. Amer. Mus. Nat. Hist. 110 (2):61-172.

GRAVES, ROBERT C.

1960. Ecological observations on the insects and other inhabitants of woody shelf fungi (Basidiomycetes: Polyporaceae) in the Chicago area. Ann. Ent. Soc. Amer. 53:61-78.

SMYTH, E. GRAYWOOD

1934. The gregarious habit of beetles. Jour. Kans. Ent. Soc. 7:102-119.

PETERSON, ALVAH

1951. Larvae of insects. Part II. Coleoptera, Diptera, Neuroptera, Siphonaptera, Mecoptera, Trichoptera. Columbus, Ohio. 416 pp.



LITERATURE NOTICE

LOWER CALIFORNIA GUIDEBOOK. By Peter Gerhard and Howard E. Gulick. Arthur H. Clark Co., Glendale, California. 3rd edition. 243 pp., 21 maps, illus. 1964. —Baja California has always been of interest to entomologists, and that interest seems to be increasing recently. Therefore, this book could be of value to many. It is a descriptive traveler's guide, composed mostly of short descriptions of places along all roads, with consecutive mileage marked for each place. It is not a scientific description of the peninsula—only 11 pages are devoted to descriptions of some game animals and distinctive plants—but interested scientists will make good use of it as a guide and gazetteer; more than 800 localities are listed. A good index and very good maps round out the contents; taxonomists with difficult locality labels from Baja will like that.